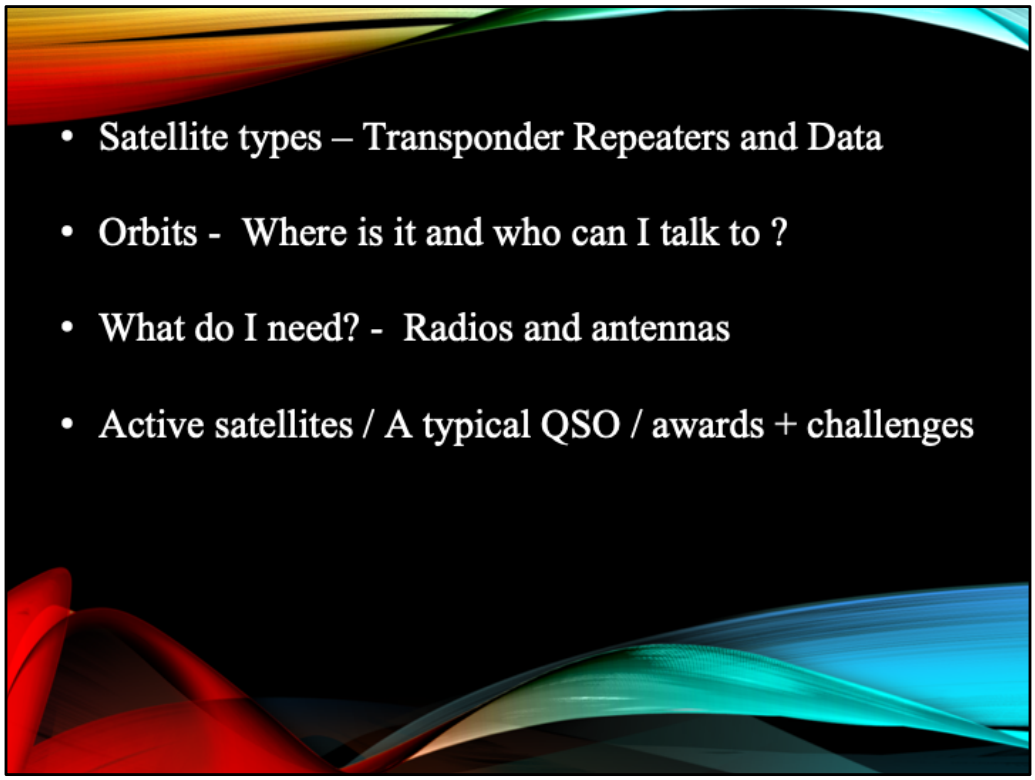
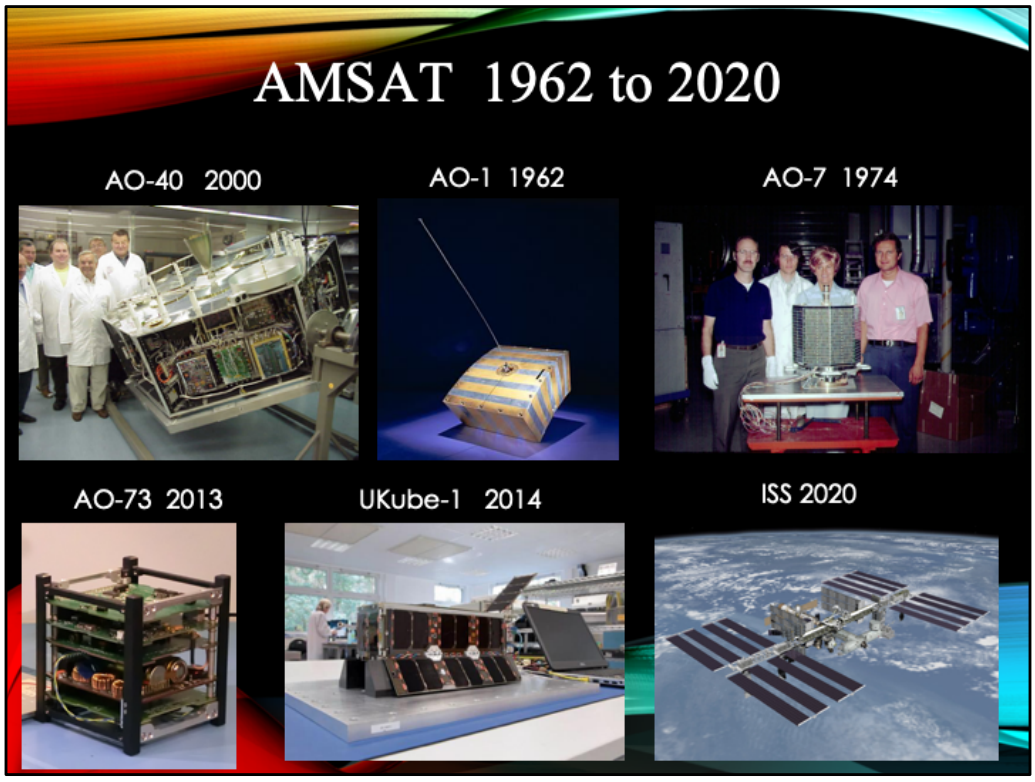
This will be a VERY introductory look at amateur radio satellite communication. The skeleton of this presentation was taken from a presentation I found online, originally given by David Bowman, Golf Zero Mike Romeo Foxtrot

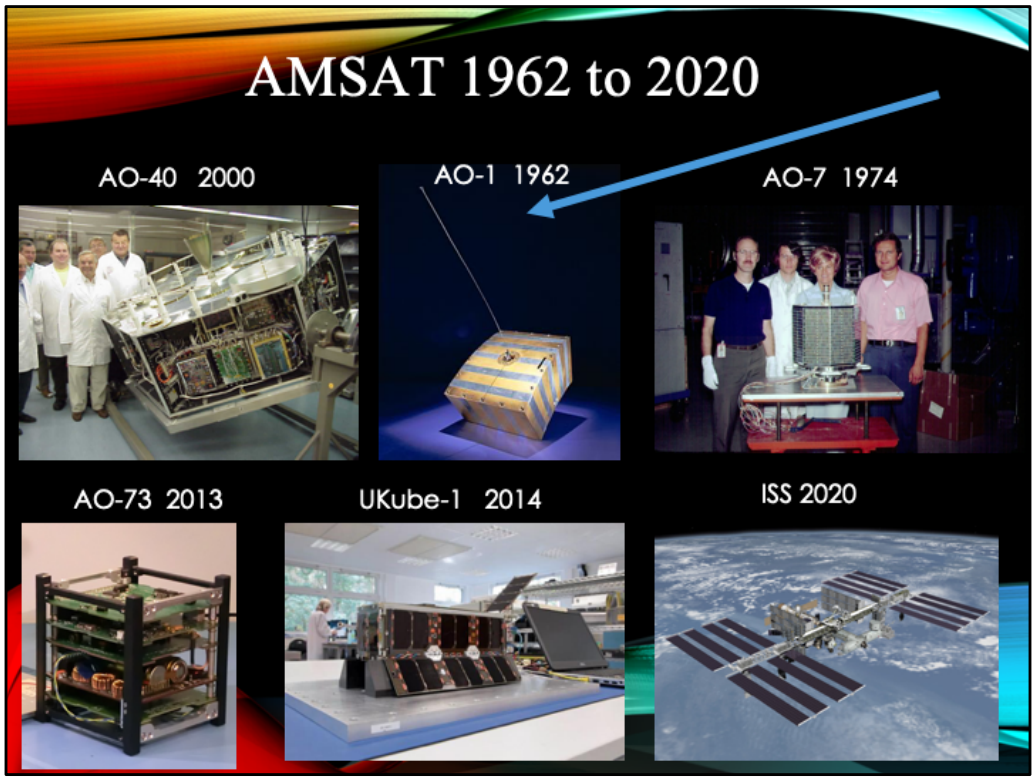


Here is a bit of a rundown on what I would like to talk about tonight

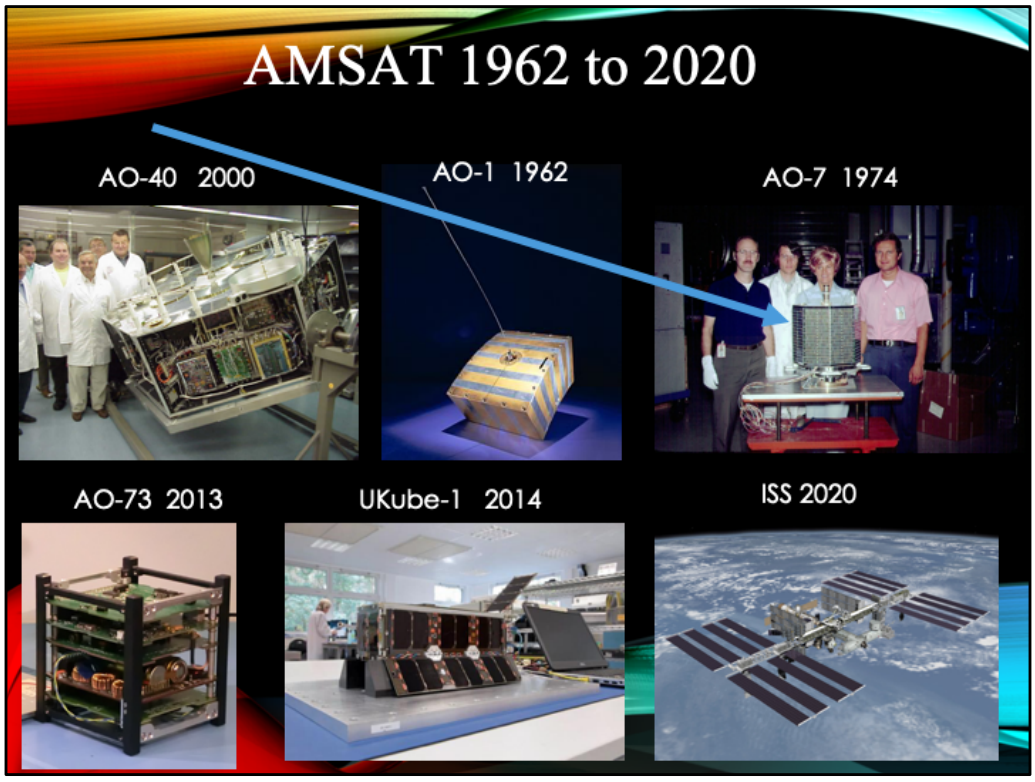


We'll start with a little bit of AMSAT history.

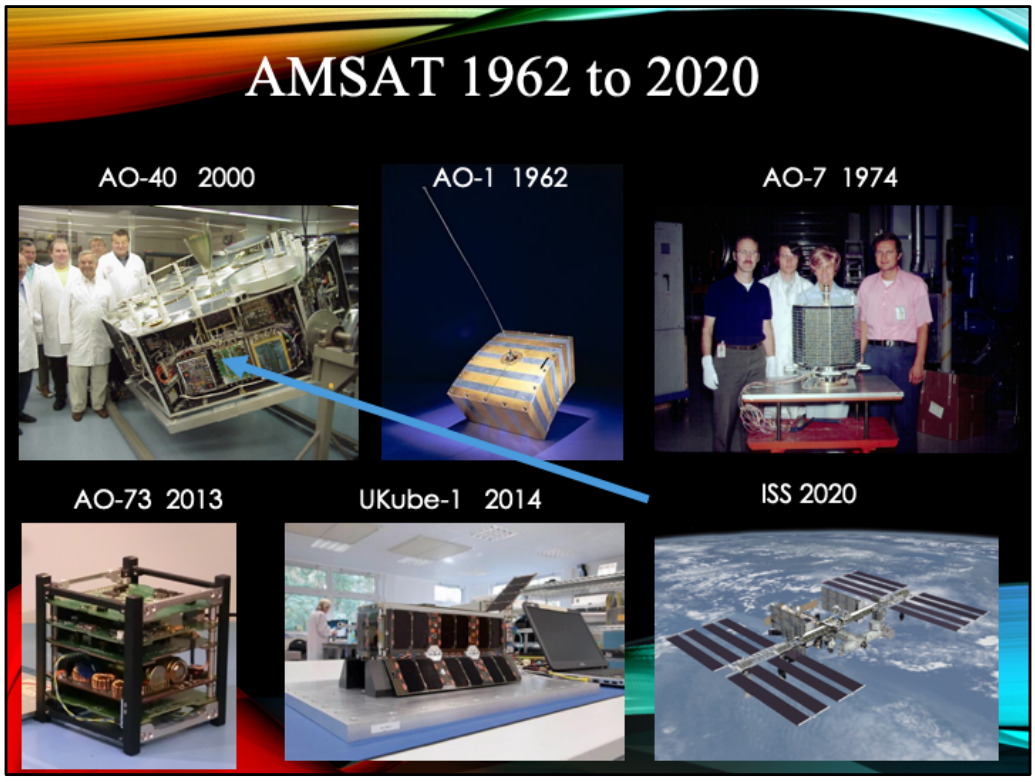
AMSAT got it's start in 1962, just 4 years after the first satellite, SPUTNIK 1 was launched. Over the past 60 years, over 60 OSCARs (orbiting satellite carrying amateur radio) have been launched. Currently there are 18 active OSCARs



AO(AMSAT OSCAR)-1 was the first AMSAT launched, and was powered by batteries and transmitted a 140mW beacon on 2m for 22 days. This first OSCAR was launched ~4 years after the worlds first satellite (SPUTNIK 1) 570 hams shared their observations back to OSCAR. AO-1 had to be build to a specific size and weight to be inserted in the payload to replace a counter-balance weight.

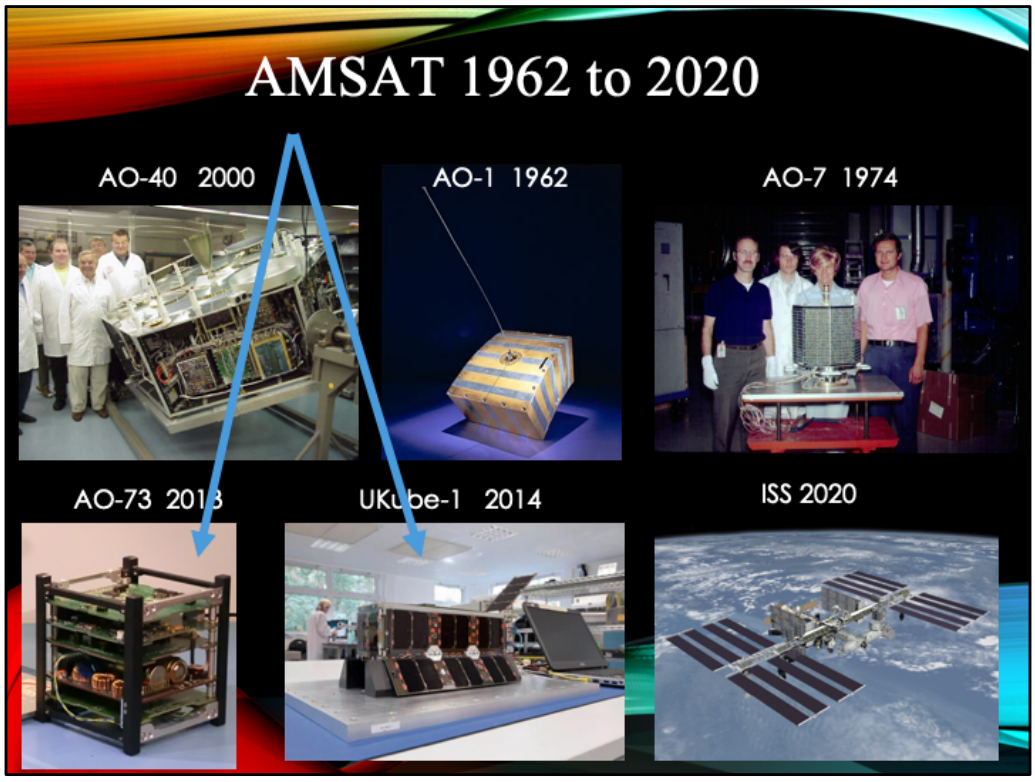


AO-7 was a typical size of satellite launched between 1970 and the early 1990s, it still works in daylight today.
Interesting history behind this bird.
In the early 80s, the battery system died and became non-operational, and in 2002, one of the shorted batteries became and open circuit, so the bird now works when it is not in eclipse and is powered by the onboard solar panel.

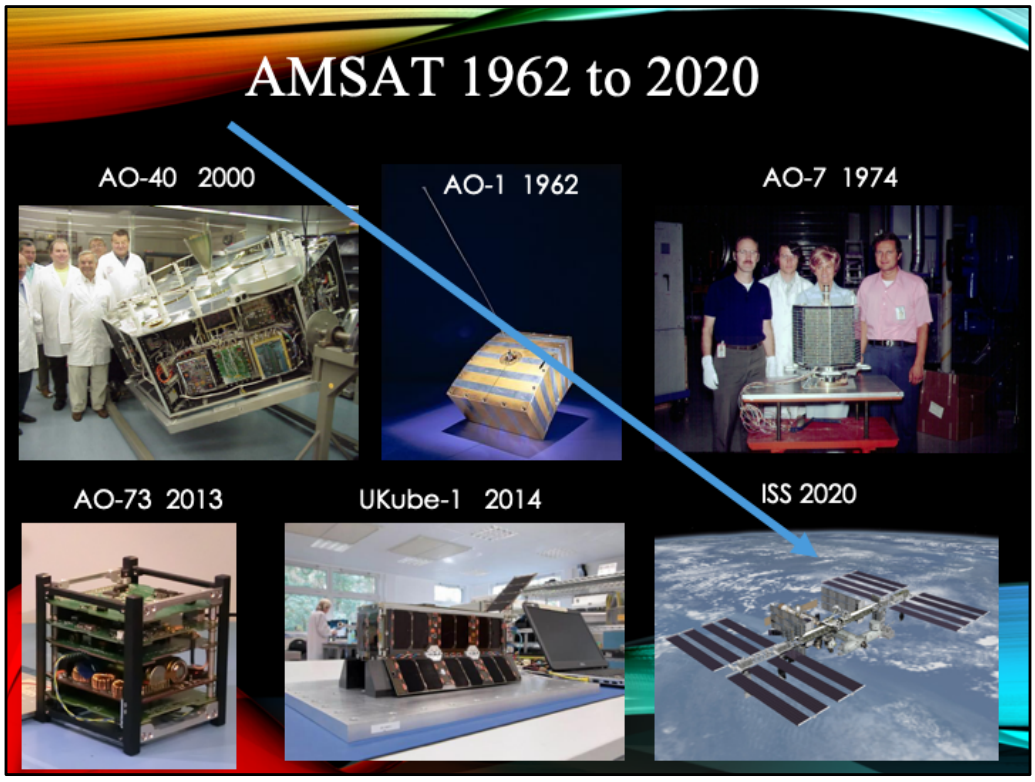


AO-40 was the largest ever produced and provided near world wide coverage when the satellite was at apogee, nearly 25,000 miles

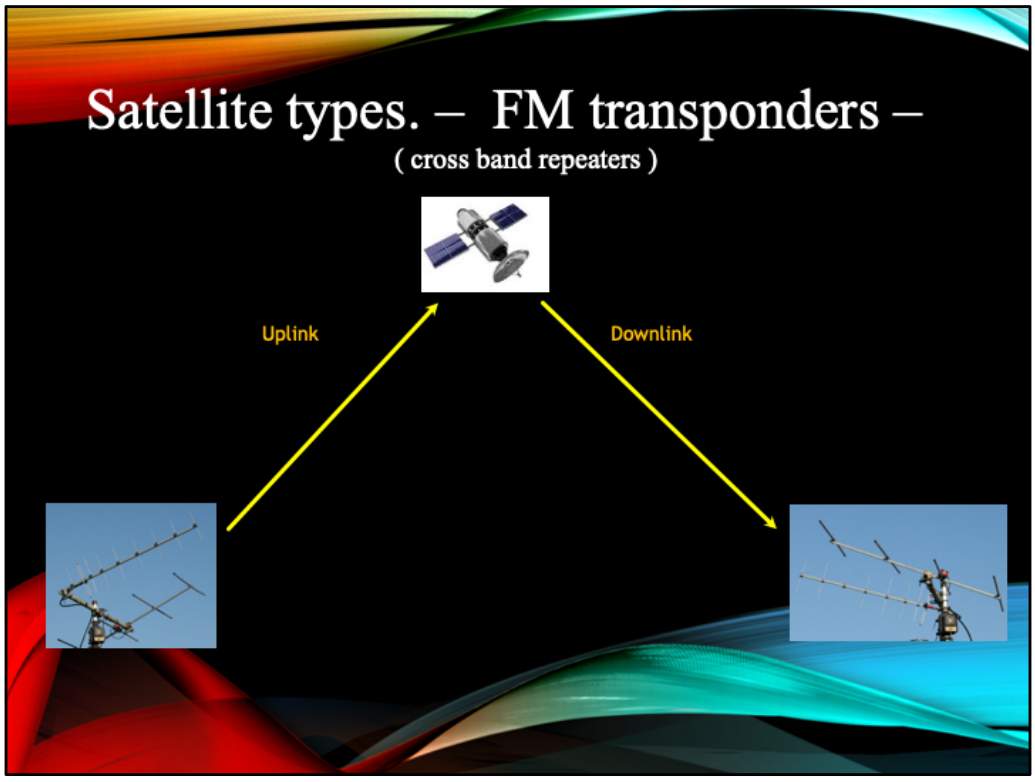
It was equipped with many transponders from 145 MHz to 24GHz. It even carried a laser communications experiment.



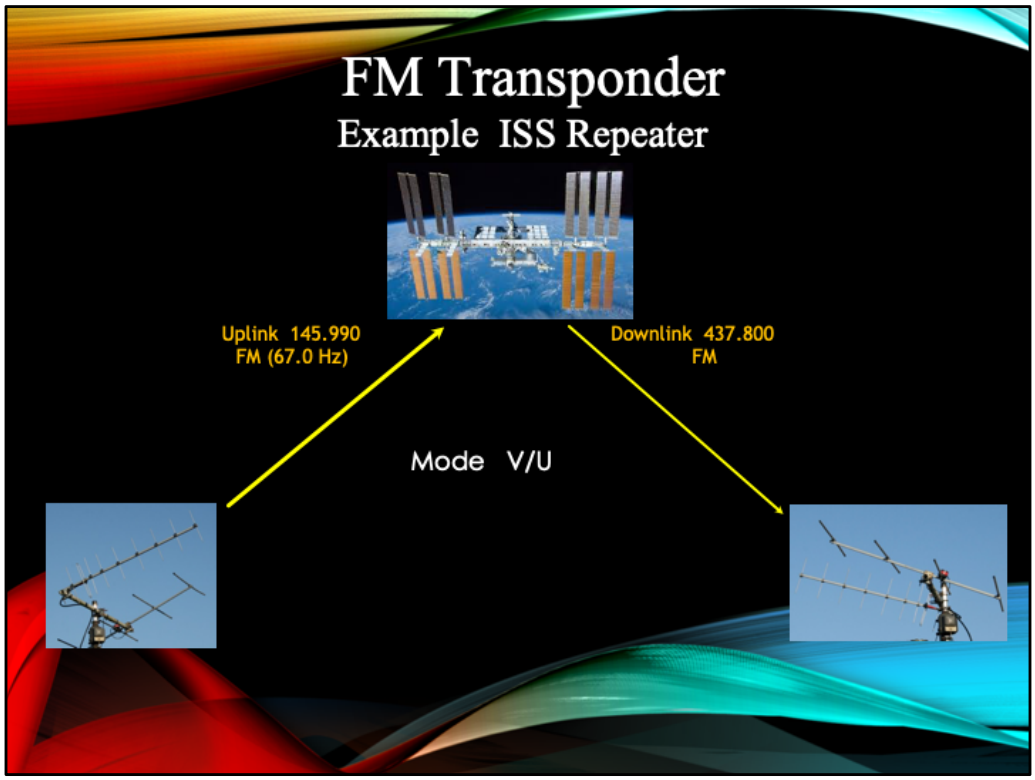
Here we see the newer generation of OSCAR…the sat cubes. AO73 is 1U satellite is a 10cm (4 in) cube with a mass of ~3lb compared to the Ukube which is a 3U….10x10x30 (4x4x12)



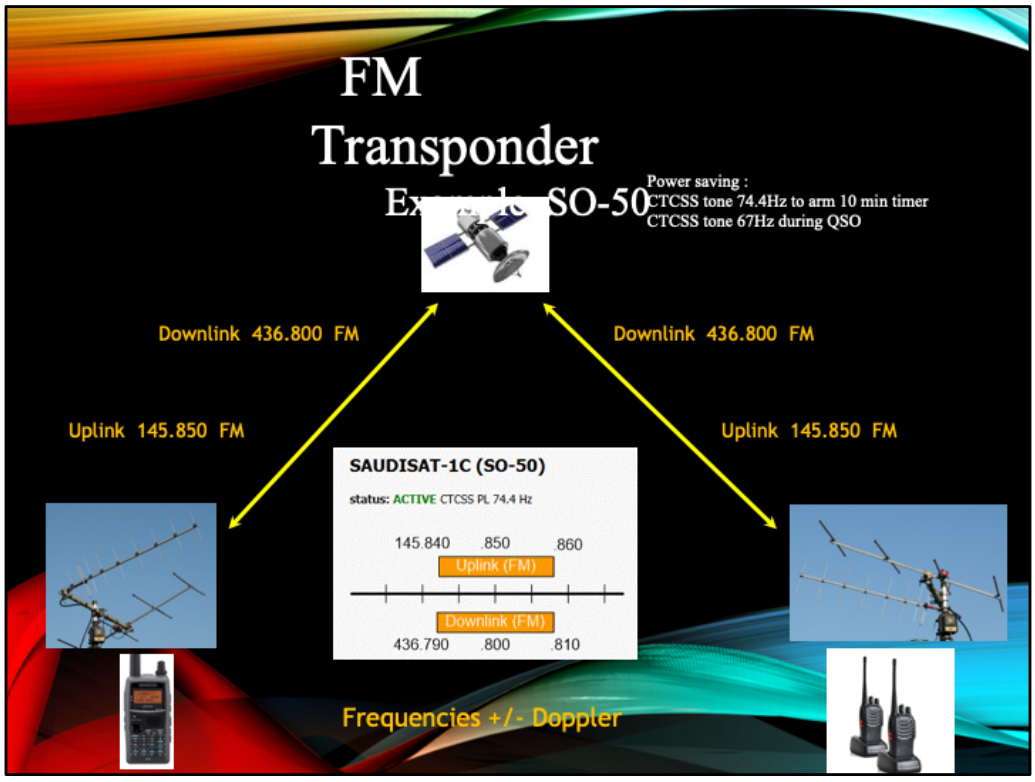
And something a little different….ARISS…amateur radio on the International Space Station. ARISS consists of a newly operational FM crossband repeater, a 2m SSTV transmitter and an APRS digipeater.



This type of OSCAR is what I am most familiar with. These birds work very similar to what we are all used to…the local FM repeater. Unlike a standard 2m or 440 repeater with a 0.6 mHz or 5 mHz offset, these repeaters work across 2m and 440. Some of you may be familiar with this cross band repeat around your house, using your HT to operate through your base station…this is exactly the same. The repeater may function in U/V or V/U.

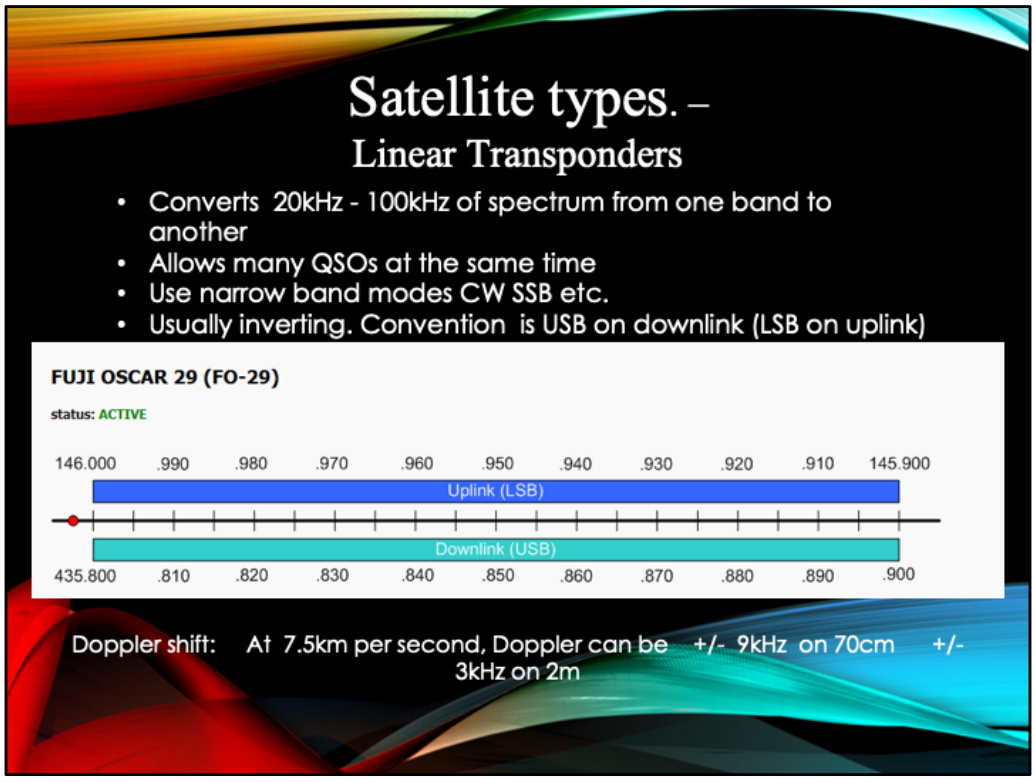


Here is the repeater aboard the ISS. You transmit on the 2m frequency 145.990 to the repeater, and your radio will receive on the 70cm frequency 437.800. Most of the OSCARs require a CTCSS tone to open the repeater, and most of them use the 67 Hz tone. They don't tone squelch, so you don't have to set a tone on receive.



Doppler shift causes the frequency of the signals to change due to the relative motion (speed) between the operator on the ground and the orbiting satellite.
The effect is at a maximum with an overhead pass. (satellite travelling 'directly' towards you as it appears over the horizon) Acquisition of signal - AOS
As the satellite approaches, a signal from it transmitted on 436.800 will appear to the operator 9kHz high on 436.809. When overhead or at time of closest approach, it will appear on 436.800.
As the satellite moves away over the horizon at the end of the pass it will appear 9 kHz low on 436.791 MHz

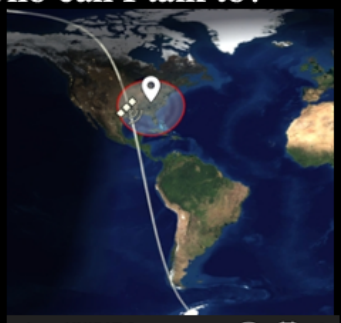
Doppler depends on relative speed and wavelength of the signal.

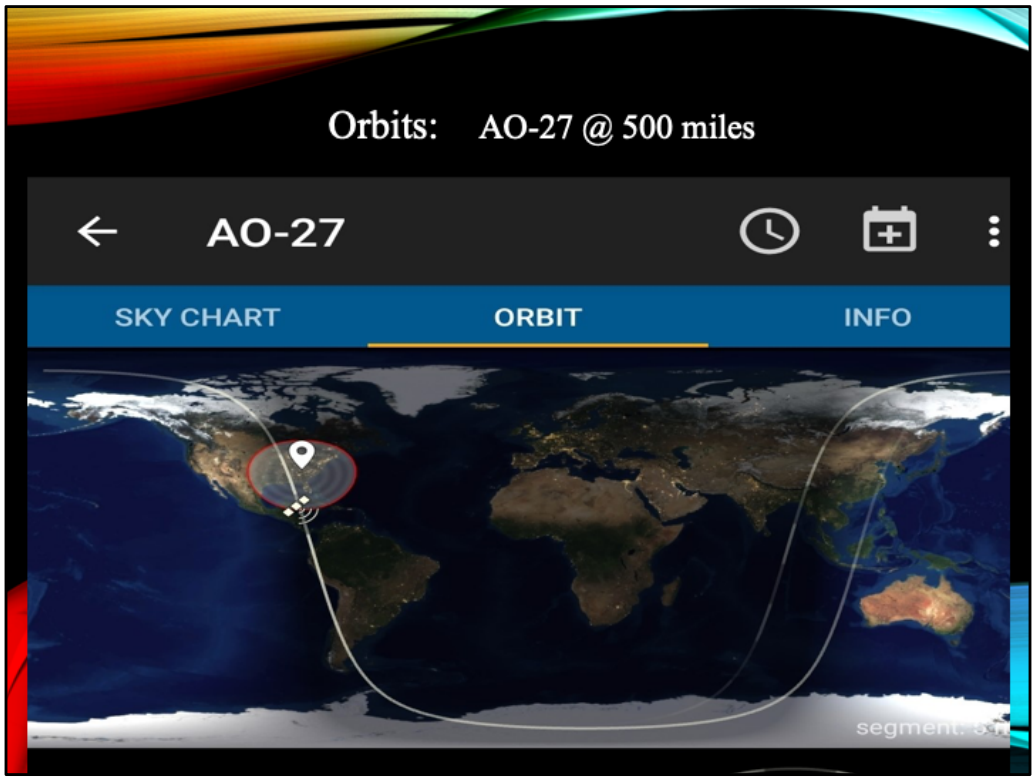


Linear transponders will convert a signal from one band to another and uses narrow band modes, typically SSB or CW. These narrow band formats allow multiple QSOs at one time

Orbits. Where is the satellite and who can I talk to?

- The higher the orbit the larger the communication 'footprint'
- Any stations who are within the satellite footprint can work each other. e.g Florida, Maine, Texas
- Low orbit = shorter pass time e.g. ISS at 250 miles is 10 minutes
- Many software tracking packages for PC and android devices or online applications




Orbits: AO-27 @ 500 miles
AO-27
SKY CHART
ORBIT
INFO

Orbits: AO-40 @ 31,000 miles (non operational)

Orbits: Tracking software

AmsatDroid. Free download for android devices. World map + sky view for pointing antennas

Heavens-Above Free download for android

ISS Detector Free download for android

Satellite Tracker Free download for iOS

Ham Radio Deluxe. Rig control, doppler shift, etc

Online: N2YO.com Uses your location and google maps for display, or pass predictions

amsat.org predictions based on grid

Radios and Antennas

Duplex – transmitting and receiving at the same time. - Is a real advantage
Duplex radios are available but 2 separate radios will work as well.
Handhelds 3 – 5W. Base stations 10 – 50W. Any radio with 2 or 70 can work

Kenwood
THD7

Yaesu FT-817

Software Defined
Radio

IC9700

IC910 or 9100 (duplex)

Radios and Antennas

Working satellites in Low Earth Orbit do not require complex antennas, but small beams will perform better than omnis, especially for transmitting.

This is a homebrew tape measure yagi, constructed for under $10 (all I had to purchase for the project was the PVC fittings
KB9VBR Tape Measure Yagi

This is a generic dual band 2m/440 yagi that has really improved my receive on 70cm

Radios and antennas

Antennas at G0MRF
4 elements on 2m + 9 element Tonna on 70cm.
Rotate in azimuth but fixed at 30 degrees elevation.

DD1US: Az/Elevation rotators with 2m / 70cm circular polarised yagis and 4 x helix for 23cm

Active satellites for voice communication (amsat.org/status for latest)

SO-50 FM repeater– 2m (145.850) up and 70cm (436.800) down
(requires 74.4 Hz tone to wake, 67.0 Hz to operate)

AO-91 FM repeater – 70cm (435.250) up and 2m (145.960) down
(requires 67.0 Hz tone to operate)

AO-92 FM repeater – 70cm (435.350) up and 2m (145.880) down
(requires 67.0 Hz tone to operate)

AO-27 FM repeater – 2m (145.8500) up and 70cm (436.795) down
(requires 67.0 Hz tone to operate)

ISS FM repeater – 2m (145.990) up and 70cm (437.800) down
(requires 67.0 Hz tone to operate)

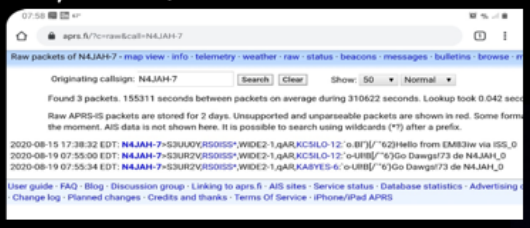
Making a satellite QSO

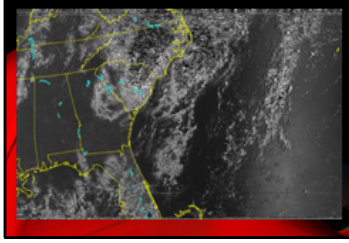
- Typical QSO: Usually short, as passes are 10-15 minutes. Longer on linear transponders
- CQ call: CQ satellite / CQ SO-50
- Answer: K9UO, N4JAH EM83
- Exchange: Signal Report and usually maidenhead locator. e.g. 59 EM83
- Power: Use minimum to complete contact. Lower power when short range
- Be prepared. – Know the satellite's track across the sky + frequencies in advance.
- Estimate Doppler correction and set the initial TX and RX frequencies.
- Wait until you hear the beacon or transponder before you transmit
- When you find your signal, if clear call CQ or retune to find clear frequency or call someone
- As you are making the QSO, keep tuning the transmitter to keep the RX frequency constant

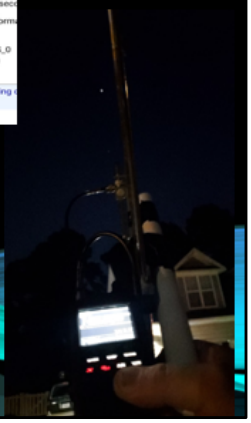
https://www.amsat.org/introduction-to-working-amateur-satellites/

Challenges and Rewards

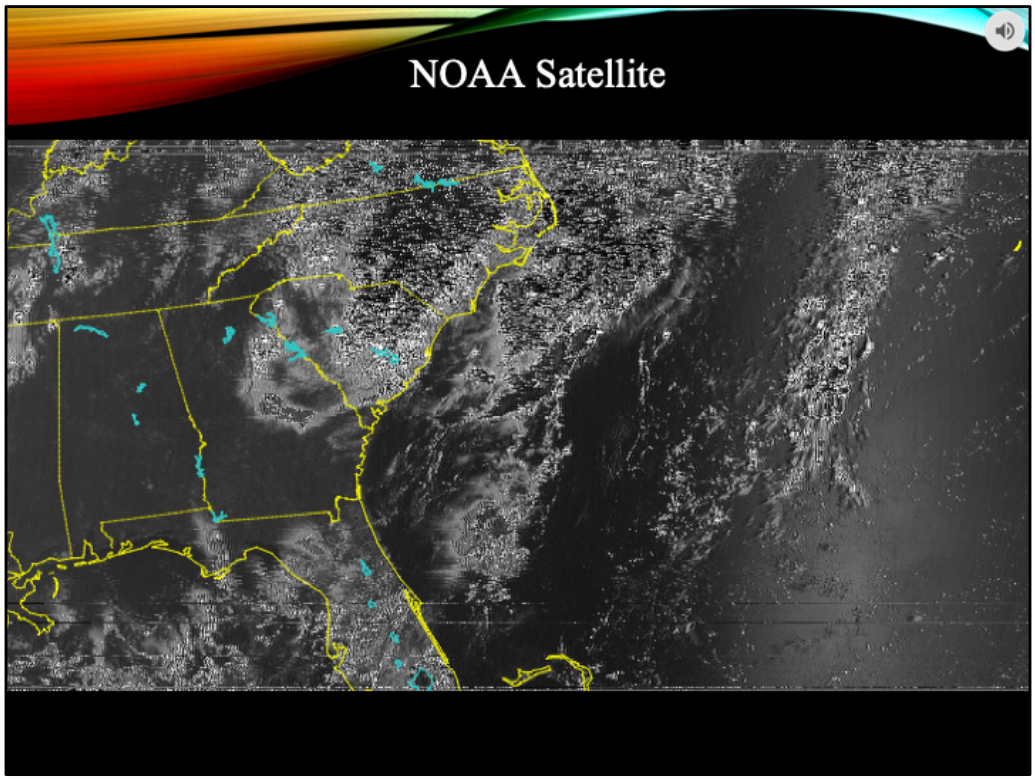
- Making your first satellite QSO is always big challenge
- There is DX to be made on satellites.
- Awards are issued by AMSAT / Satellite teams and National organisations







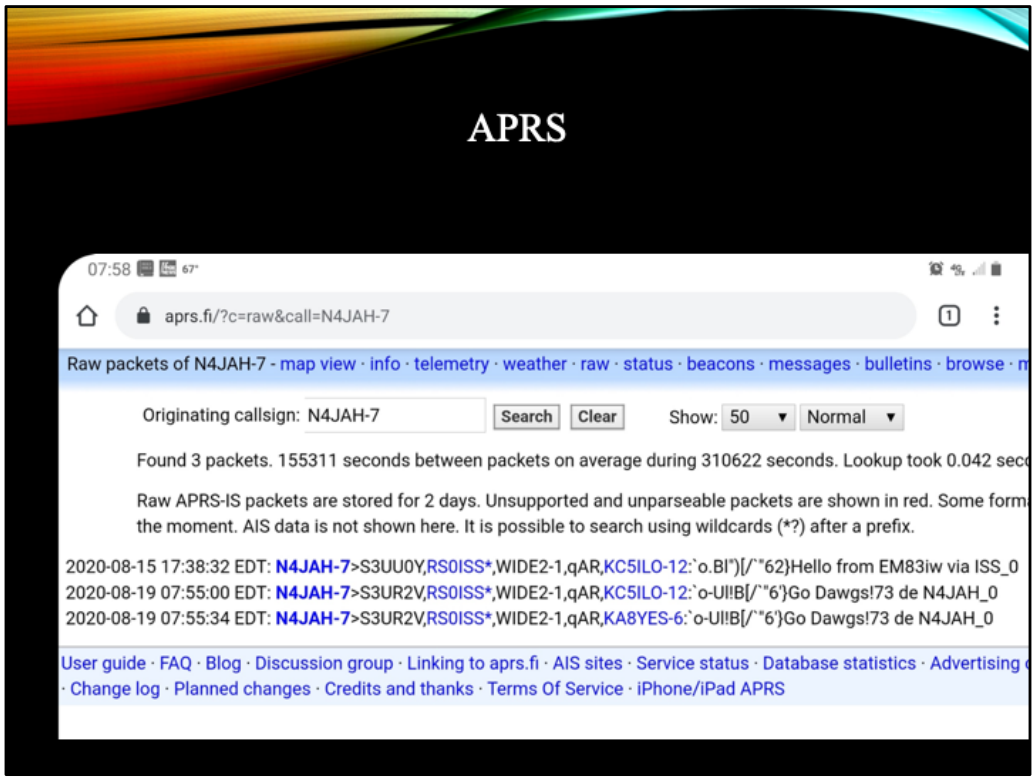
Much like this dog, I had the equipment, I was heading in the right direction but I had no idea what I was doing…but I knew I was happy about it



Much to my neighbors bewilderment, I stood out in the front yard with a phone, an HT and a chopped up tape measure, pointing it at an empty sky.

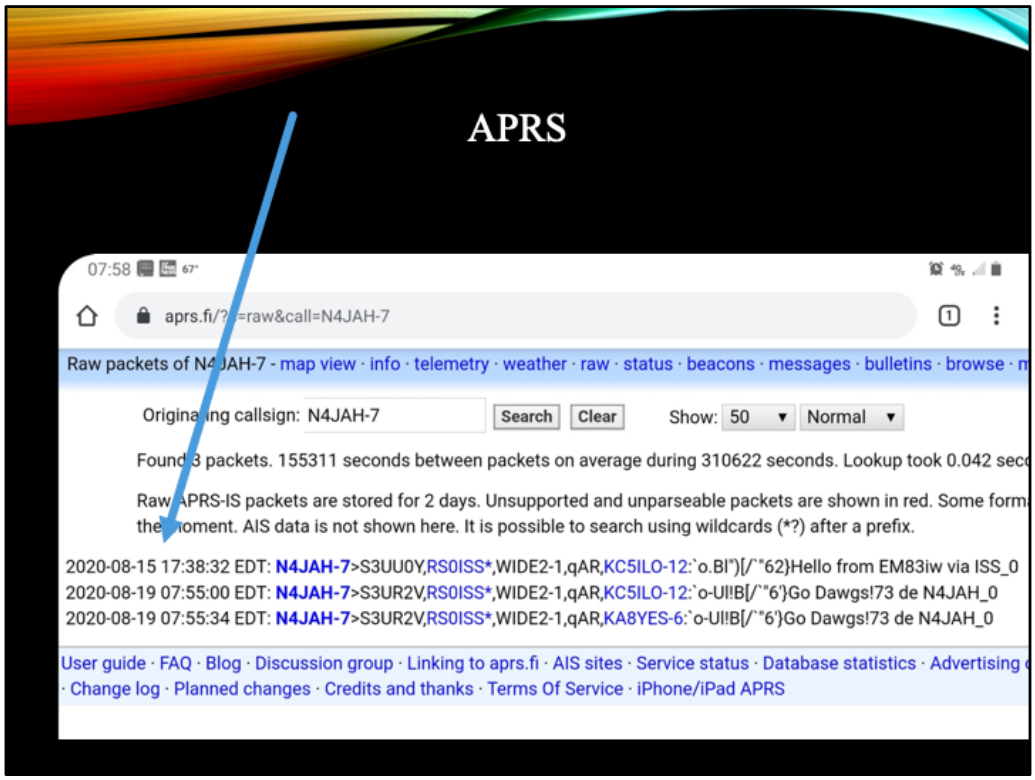
I heard a bunch of beeps so I hit record on the HT. The beeps disappeared, I stopped the recording and popped the SD card in the computer.

SSTV
ARISsat-1 / UNESCOsat-1 / KEDR RS1S launched - 02.02.2006 year
Mission: Automatic transmission of 25 greetings
messages in 15 languages in honor of the 50th anniversary of the flight of the
first person into space Photographing of the Earth and telemetry information.
Миссия: передача в автоматическом режиме 25 приветственных
сообщений на 15 языках в честь 50-летия полета первого человека
в космос фотографирование Земли и телеметрическая информация.
RS0ISS
Serie 16 - 8/12



Several OSCARs carry APRS digipeaters

In the US, APRS is 144.390, for OSCAR 145.825


APRS
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aprs.fi/?=raw&call=N4JAH-7
Raw packets of N4JAH-7 - map view · info · telemetry · weather · raw · status · beacons · messages · bulletins · browse ·
Originating callsign: N4JAH-7
Search
Clear
Show: 50
Normal
Found 3 packets. 155311 seconds between packets on average during 310622 seconds. Lookup took 0.042 sec
Raw APRS-IS packets are stored for 2 days. Unsupported and unparseable packets are shown in red. Some form
the moment. AIS data is not shown here. It is possible to search using wildcards (*?) after a prefix.
2020-08-15 17:38:32 EDT: N4JAH-7>S3UU0Y,RS0ISS*,WIDE2-1,qAR,KC5ILO-12:`o.Bl")[/`"62}Hello from EM83iw via ISS_0
2020-08-19 07:55:00 EDT: N4JAH-7>S3UR2V,RS0ISS*,WIDE2-1,qAR,KC5ILO-12:`o-Ul!B[/`"6'}Go Dawgs!73 de N4JAH_0
2020-08-19 07:55:34 EDT: N4JAH-7>S3UR2V,RS0ISS*,WIDE2-1,qAR,KA8YES-6:`o-Ul!B[/`"6'}Go Dawgs!73 de N4JAH_0
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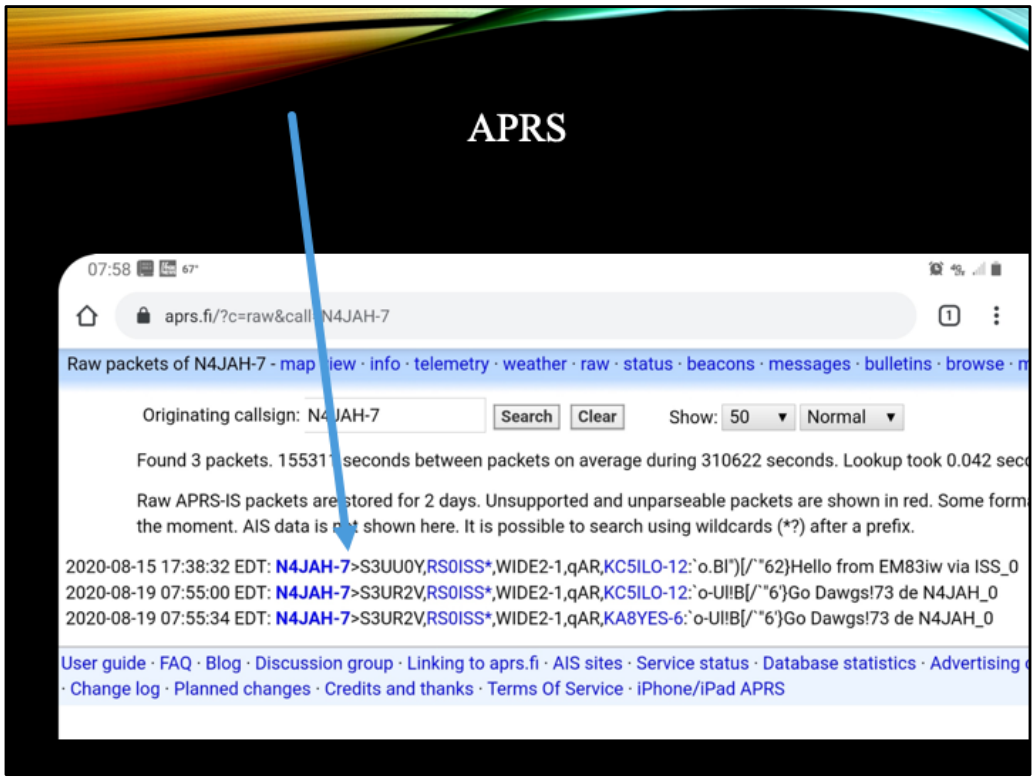
· Change log · Planned changes · Credits and thanks · Terms Of Service · iPhone/iPad APRS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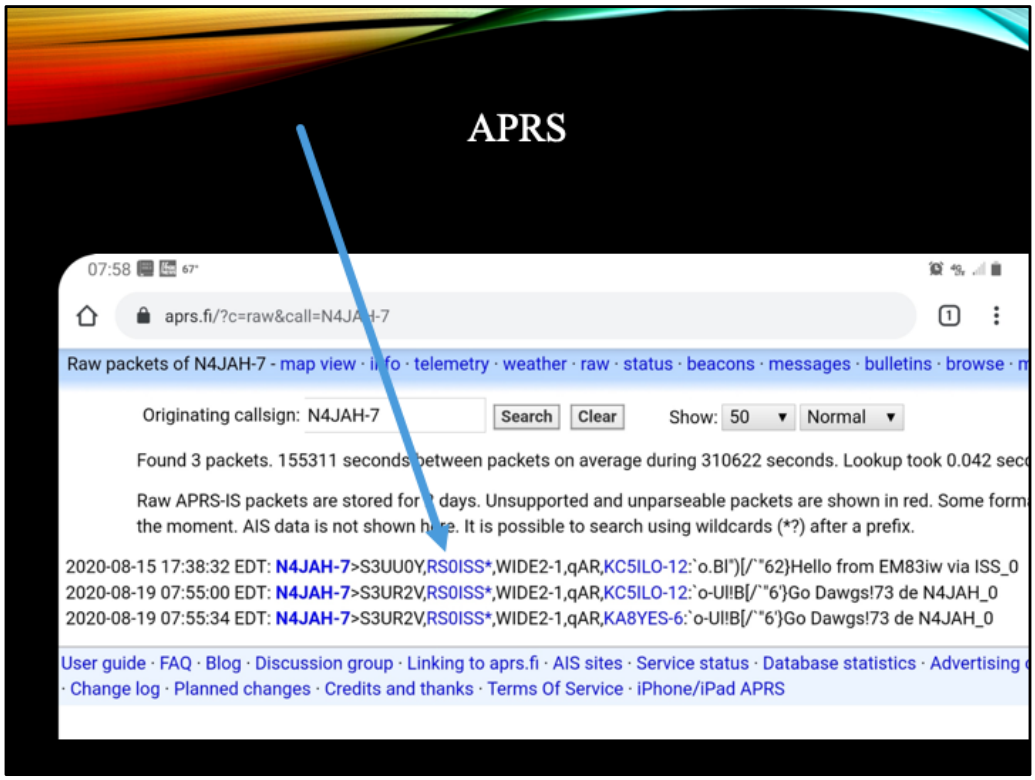
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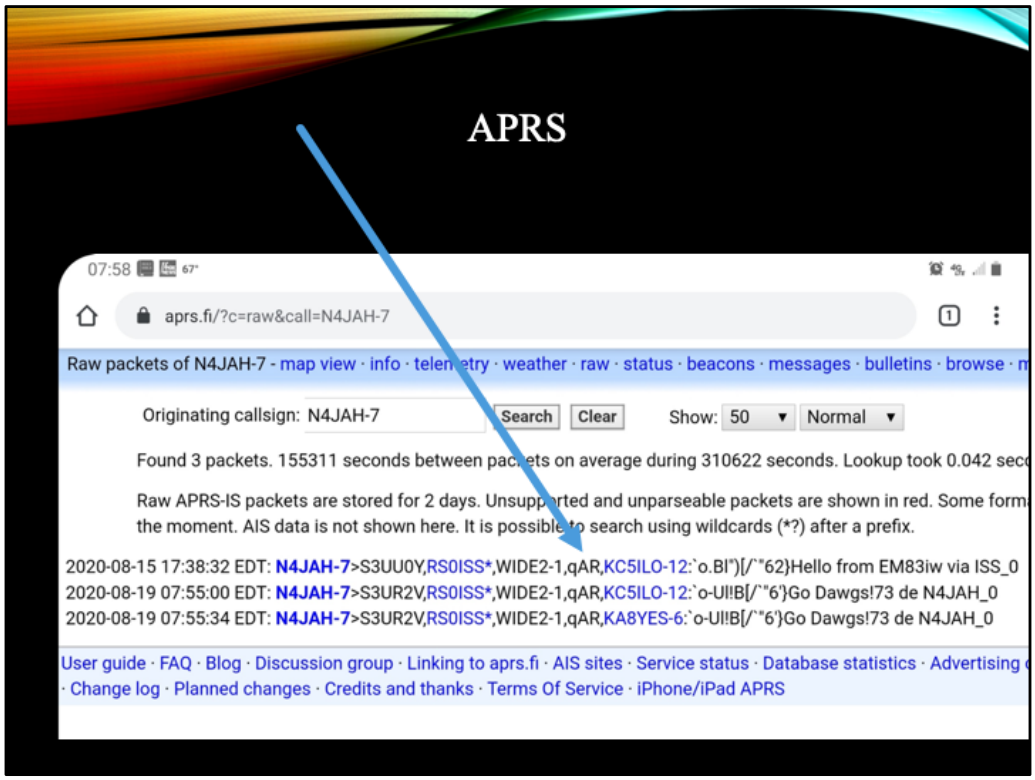
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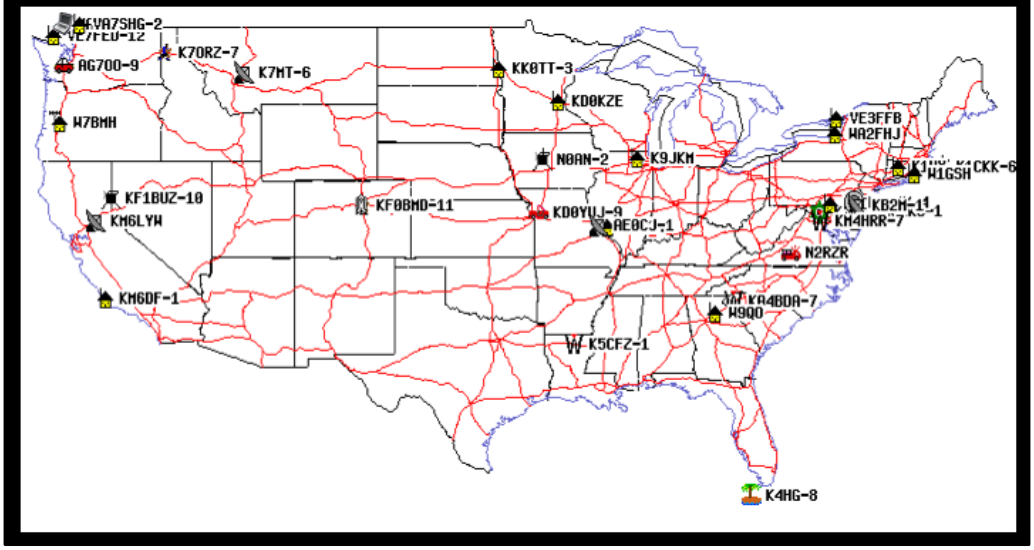
APRS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AG7OO-9
K7ORZ-7
K7MT-6
W7BMH
KK0TT-3
KD0KZE
N0AN-2
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VE3FFB
WA2FHJ
W1GSH
CKK-6
KF1BUZ-10
KM6LYW
KF0BMD-11
KD0YUJ-9
AE0CJ-1
KB2M-11
KM4HRR-7
N2RZR
KM6DF-1
KA4BDA-7
W9QO
K5CFZ-1
K4HG-8

ISS 02 Oct – Listen for K9UO

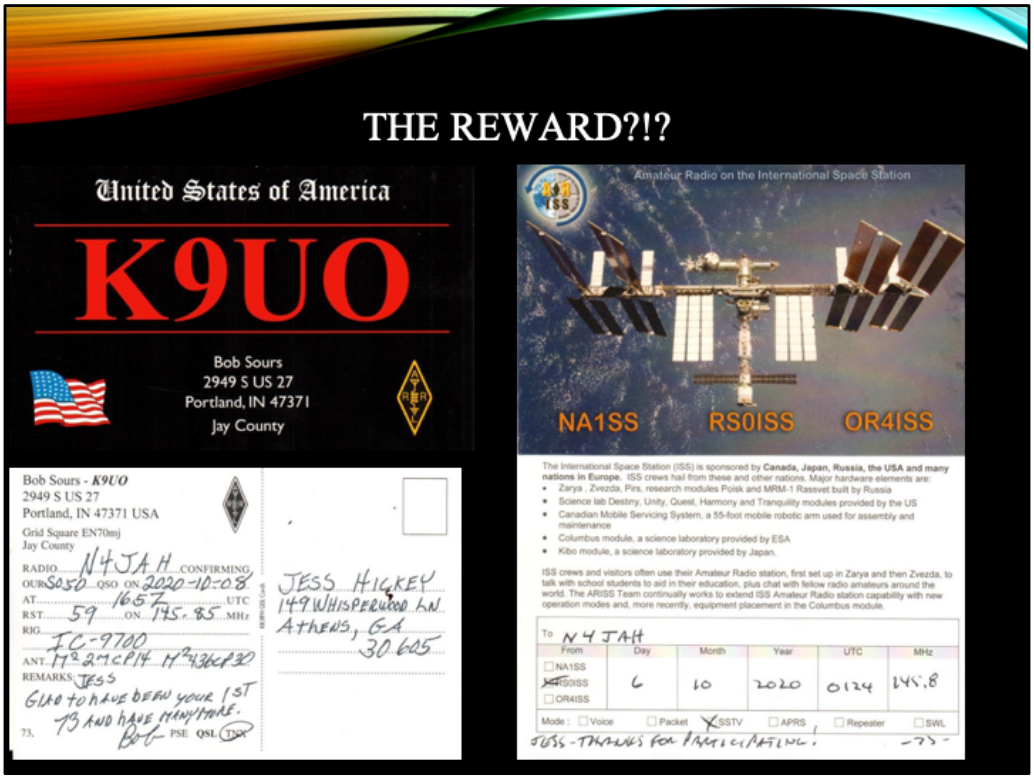
Much like this dog, I had the equipment, I was heading in the right direction but I had no idea what I was doing…but I knew I was happy about it

VOICE CONTACT

THE REWARD?!?

The first satellite to orbit the Earth - October 4, 1957
Спутник-1
ARISS SSTV Award
№ 161077
Jess Hickey N4JAH
RSOISS
Amateur Radio on the International Space Station
Любительское радио на борту Международной космической станции

THE REWARD?!?


United States of America
K9UO
Bob Sours
2949 S US 27
Portland, IN 47371
Jay County
Bob Sours - K9UO
2949 S US 27
Portland, IN 47371 USA
Grid Square EN70mj
Jay County
RADIO N4JAH CONFIRMING
OUR S050 QSO ON 2020-10-08
AT 1657 UTC
RST 59 ON 145.85 MHz
RIG IC-9700
ANT M2 2MCP14 M2 436CP30
REMARKS JESS
GLAD TO HAVE BEEN YOUR 1ST
73 AND HAVE MANY MORE.
Bob
PSE QSL TNX
JESS HICKEY
149 WHISPERWOOD LN
ATHENS, GA
30605
Amateur Radio on the International Space Station
NA1SS
RS0ISS
OR4ISS
The International Space Station (ISS) is sponsored by Canada, Japan, Russia, the USA and many nations in Europe. ISS crews hail from these and other nations. Major hardware elements are:
Zarya , Zvezda, Pirs, research modules Poisk and MRM-1 Rassvet built by Russia
Science lab Destiny, Unity, Quest, Harmony and Tranquility modules provided by the US
Canadian Mobile Servicing System, a 55-foot mobile robotic arm used for assembly and maintenance
Columbus module, a science laboratory provided by ESA
Kibo module, a science laboratory provided by Japan.
ISS crews and visitors often use their Amateur Radio station, first set up in Zarya and then Zvezda, to talk with school students to aid in their education, plus chat with fellow radio amateurs around the world. The ARISS Team continually works to extend ISS Amateur Radio station capability with new operation modes and, more recently, equipment placement in the Columbus module.
To N4JAH
From
NA1SS
RS0ISS
OR4ISS
Day 6
Month 10
Year 2020
UTC 0124
MHz 145.8
Mode : Voice Packet SSTV APRS Repeater SWL
JESS - THANKS FOR PARTICIPATING! -73-

THANK YOU